MALAYSIAN PARASITES VI

INDO-MALAYSIAN CHIGGERS OF THE SUBGENUS *SCHÖNGASTIELLA* (ACARINA TROMBICULIDAE)*

By

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During the war years intensive studies on scrub typhus were undertaken by the United States of America Typhus Commission in Assam and Burma. Postwar investigations on this mite-borne disease have been carried out in Malaya by the Colonial Office Research Unit and the U.S. Army Medical Research Unit, both headquartered at the Institute for Medical Research, Kuala Lumpur. As a result of these projects, quantities of trombiculid mites or chiggers have become available for study, including new and little-known species.

The present paper includes descriptions of the larvae of seven new species of the subgenus *Schöngastiella* (Hirst, 1915) of the genus *Gahrliepia* Oudemans, 1912, as well as records of *G.* (*S.*) *punctata* (Radford, 1946) and *G.* (*S.*) *ligula* (Radford, 1946). This group of mites is of potential medical significance, although its role has never been evaluated. The subgenus was regarded as wholly Indo-Malayan, but it has recently been reported in Africa (Andrè, 1951). The fact that new species are currently being described by other workers, whereas other species are yet poorly known and inadequately collected, makes it impossible to prepare a revision of this subgenus at the present time.

One of the Assam-Burma new species is described in detail. The other new forms are compared with the first, and only major differences are noted in order to save space. All these are illustrated in full. For purposes of ready comparison, a table is included which lists pertinent and significant data and measurements. In addition to the valuable measurements introduced by Womersley and Heaslip (1943), and which are now standard, new metric data and proportions, as well as terms and abbreviations, are included in the present paper. Among these are: (*a*) the pseudo-posterolateral setae (PPL): the pair of abdominal setae encompassed by the enlarged scutum, and which at first glance appear to be the posterolaterals; (*b*) PPW: the width in microns between PPL; (*c*) PP: the distance in microns between PPL and the posterior margin of the scutum; (*d*) A-PP: the distance between AL and PPL; and (*e*) DS: the length of typical dorsal setae. The ratio of PW to the scutal depth SD (=ASB+PSB), is a useful one, and serves to statistically equalize the apparent difference between the actual measurements of disproportionately large or small specimens of the same species. Important in this regard is the ratio of PW to the length of coxa II (*see* Traub and Audy, 1953, this *Study* p. 74). This ratio appears to be quite constant regardless of the size of the individual. The length of coxa II is measured as illustrated in fig. 3, i.e., from the base of the coxa (*not* the more contiguous plate, which is difficult to see in long-mounted specimens) to the tip of the apical spur on the anterior margin. The setation of the palpae is expressed by means of a formula after Audy (1952) e.g. N/N/BNB, in which the first letter refers to the seta on the palpal femur, the second to that of the genu, and the next three to the dorsal, lateral, ventral setae on the tibia, respectively. The letter N signifies the seta is nude, and B barbed. Where a bristle is mainly nude but lightly frayed or ciliated in one or two places the designation would be N(*b*).

Gahrliepia (**Schöngastiella**) **liota** n. sp. (figs. 1-9).

Diagnosis of Larvae.—Near *G.* (S) *ligula* (Radford, 1946) (figs. 61-68) in that the scutum is constricted beyond PL, the portion of the plate posterior to these bristles being somewhat narrowed (Radford, 1946). Separable in that the hind coxae possess two bristles, not one;

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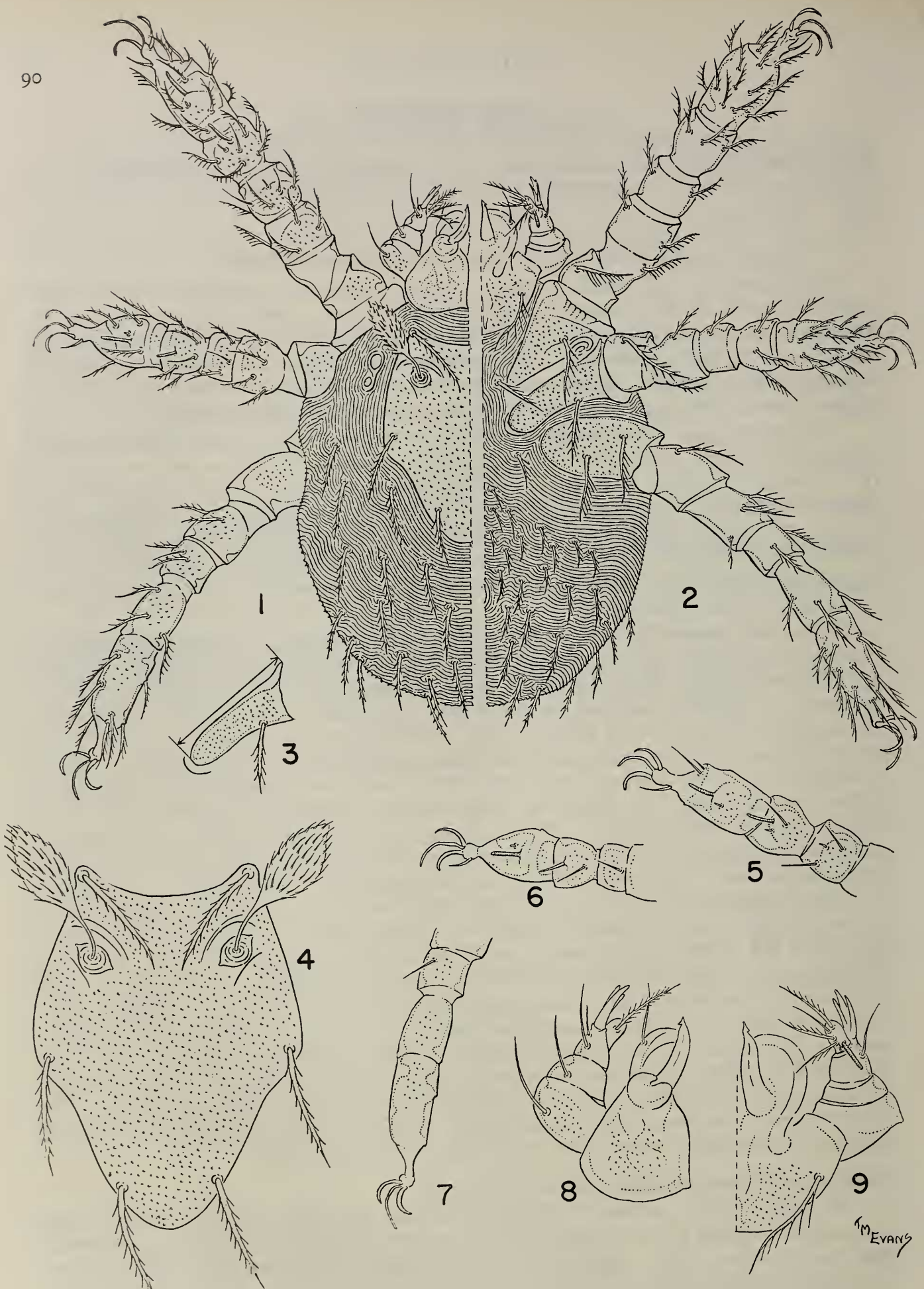


Gahrliepia (*Schöngastiella*) *liota* n. sp.

Dorsum and Venter of Larva 1, 2
Coxa II showing measurement for PW/Coxa-II ratio 3
Scutum 4
Legs I, II, III 5, 6, 7
Mouthparts, Dorsal 8
Ventral 9

the posterior portion of the scutum is not nearly as narrow or ligulate; also distinct in that the scutum is smaller, i.e., AW 28-30μ instead of with a mean of 39μ; PW about 45, not 52; with A-PP 56, not 71, but nevertheless A-P is about 36 while in *G.* (S) *ligula* the mean is 39.

Description of Larva.—Body: Subovate, somewhat constricted at anterior third, engorged specimen about 325μ (including mouth-parts) long by 214μ broad; ovate if not fully engorged. Eyes double, indistinct in specimens extant; apparently total dimensions about 13×5μ. *Gnathosome*: chelicers about four or five times as long as broad at base; with a single subapical notch. Palpal coxae and femora punctate. Palpal setae as follows: femoral seta long, nude; genual seta similar, as are the three tibial setae. Thus the palpal setae formula is N/N/NNN. Palpal tarsus with a basal striated rod and about 5 bristles, some subapical, 4 of these heavily plumose, 1 apparently nude. Palpal claw trifurcate, of which only two prongs are readily discernible. Galeal seta simple. Maxillary seta plumose. *Scutum:* subpentagonal, but with angles rounded; with anterior margin slightly concave; broadest at insertion of posterolateral bristles (PL), then narrowing noticeably; margins slightly sinuate between anterolateral bristles (AL) and posterolateral bristles (PL), and more sinuate between PL and what are here designated as pseudo-posterolateral bristles (PPL) caudal margin broadly U-shaped posterior to PPL and extending beyond these bristles for a distance of about 1/8-1/10 length of plate. Dimensions of scutum in holotype: 76×50μ. Lightly punctate, lacking striations of body. Cristae fairly well developed. Pseudostigmatic organs (sensillae) somewhat fusiform but with petiolate base; about 40μ (total length, including petiole) by 9μ; barbules rather appressed; inserted at a level more than one-third length between AL and PL. Scutum setae well developed, heavily plumose; pseudo-posterolateral bristles (PPL) close together as compared with AL and PL. *Body Setae:* Dorsal setae similar to scutal setae; about 30 in number in rows 2,4,6,6,6,

STANDARD MEASUREMENTS IN MICRONS, *G. liota* n. sp.

U.S.A.T.C. Slide No.	AW	PW	PPW	SB	ASB	PSB	A-P	A-PP	PP	AL	PL	PPL	DS	PW / Coxa II	PW / SD
3,561- 1	30	46	19	29	16	60	35	58	18	27	28	22	24	46/43 =1.07	46/76 =0.6
3,579- 2	30	49	21	31	16	60	36	56	20	27	28	23	24	49/45 =1.1	49/76 =0.6
1,482-24	28	45	22	28	16	58	35	54	20	26	27	24	25	45/42 =1.07	45/74 =0.6
2,044- 5	28	43	21	27	15	58	35	54	20	26	28	22	25	43/42 =1.0	43/74 =0.6
3,662- 1	31	47	21	27	16	62	36	58	19	27	27	23	24	47/44 =1.08	47/78 =0.6

the rest irregular. With a single pair of sternal setae between bases of coxae I and another smaller pair between coxae III. Ventral setae thin, short, plumose, about 40 in number, most about 13 microns in length. *Legs:* Coxae and legs punctate. Coxae I and II unisetose, the seta caudomarginal on II, nearly so on I; coxae III with two submedial setae. Sensory setae as follows: Leg I with 2 genualae, 1 microgenuala, 2 tibialae, 1 microtibiala, 1 spur, 1 microtarsala proximal to tarsala, 1 subterminala, 1 parasubterminala and 1 pretarsala. Leg II with 1 genuala, 2 tibialae, 1 tarsala spur, 1 adjacent microtarsala and one pretarsala. Leg III with 1 genuala. Tarsal claws triunguiculate, the middle claw slightly longer than other.

Type Material.—Collected in Assam, India, from true shrews, by members of the United States of America Typhus Commission in 1945. Holotype (U.S. National Museum 2066; U.S.A.T.C. 3561-1) ex *Suncus caerulaeus fulvocinereus* Anderson, 22 miles north of Ledo on the Stilwell Road, 29. viii. 1945. A paratype with same data but 28. viii. A paratype ex *Suncus, loc. cit.* but taken at the 4.6 mile mark, 7. ix. A third paratype ex *Anourosorex squamipes assamensis* Anderson, a short-tailed shrew, but at the 15 mile mark, 27. vii. A fourth paratype ex *Crocidura* sp. at the 21 mile mark, 29. vii. Holotype and two paratypes deposited in the U.S. National Museum. Two paratypes in collection of senior author.

Gahrliepia (Schöngastiella) erula n. sp. (Figs. 10-17).

Diagnosis of Larva.—Near *G.* (*S*) *punctata* (Radford, 1946) (figs. 69-76) in that the scutum is very broad and long, the scutal depth being over 105 and with PW over 60μ. Readily separable in that the third coxae are unisetose instead of bearing 2 setae; the lateral margins of the scutum are evenly and gently convex, not angulate at level of PW and then rapidly converging; with PPW over 64μ, not merely in the vicinity of 41μ.

Description of Larva.—Body: subspherical in unengorged specimens, approximately 240μ long by 180 broad; engorged specimens ovate, broadest behind coxae III, about 505×370μ. Anterior eye 13×9μ, posterior eye about 9×4μ. *Gnathosome:* as in *liota* n. sp. *Scutum:* very large, about 130×80μ; elongate oval but anterior margin almost straight, very shallowly concave; lateral margins slightly convex; posterior margin evenly and deeply rounded; extending beyond PPL for a distance nearly one-third length of scutum. Sensillae about 36×15μ, inserted at a level nearly midway between AL and PL. Scutal setae nearly contiguous with lateral margins of plate; PPL slightly further apart than are PL. *Body Setae:*

Gahrliepia (Schöngastiella) erula n. sp.

Dorsum and Venter of Larva 10, 11

Scutum 12
Legs I, II, III 13, 14, 15
Mouthparts, Dorsal 16
Ventral 17

STANDARD MEASUREMENTS IN MICRONS, *G. erula* n. sp.

Slide	AW	PW	PPW	SB	ASB	PSB	A-P	A-PP	PP	AL	PL	DS	PW / Coxa II	PW / SD
Holotype ...	40	75	75	45	22	103	40	90	35	31	36	26	75/57 =1.31	75/125 =0.6
Paratypes (6) Mean ...	38	70	72	42	19	106	39	89	36	30	35	28	1.3	0.6
Range (+ or −) ...	3	5	8	3	3.3	5	3	2	6	1	2	2.3	—	—

Dorsal setae similar to scutal setae in morphology but slightly smaller; about 28 or 30 in number (deleting PPL), arranged in rows of 2.4.8. or 2.6.6., the rest irregular. At times one or two of the four dorsal setae appear to be contiguous with scutal margin. Ventral setae thin, sparsely plumose, definitely shorter than dorsal setae, the anteriormost about 12μ in length, the postanals (referred to by Audy, 1952, as caudal setae) about 22. All coxae with one seta.

Type Material.—Collected at Shingbwiyang or else 10 miles north of Myitkyina, North Burma, by members of U.S. Typlus Commission ex *Rattus fulvescens fulvescens* (Gray), *Rattus rattus sladeni* (Anderson) and *Rattus flavipectus yunnanensis* (Anderson) in 1945. Holotype (U.S.N.M. 2067; U.S.A.T.C. 906-17) ex *Rattus rattus sladeni*, Shingbwiyang, 6. iv. 1945. Sixteen paratypes from these hosts and localities deposited in the collections of the U.S. National Museum, the Colonial Office Research Unit at Kuala Lumpur, in the collections of the senior author and in various institutions.

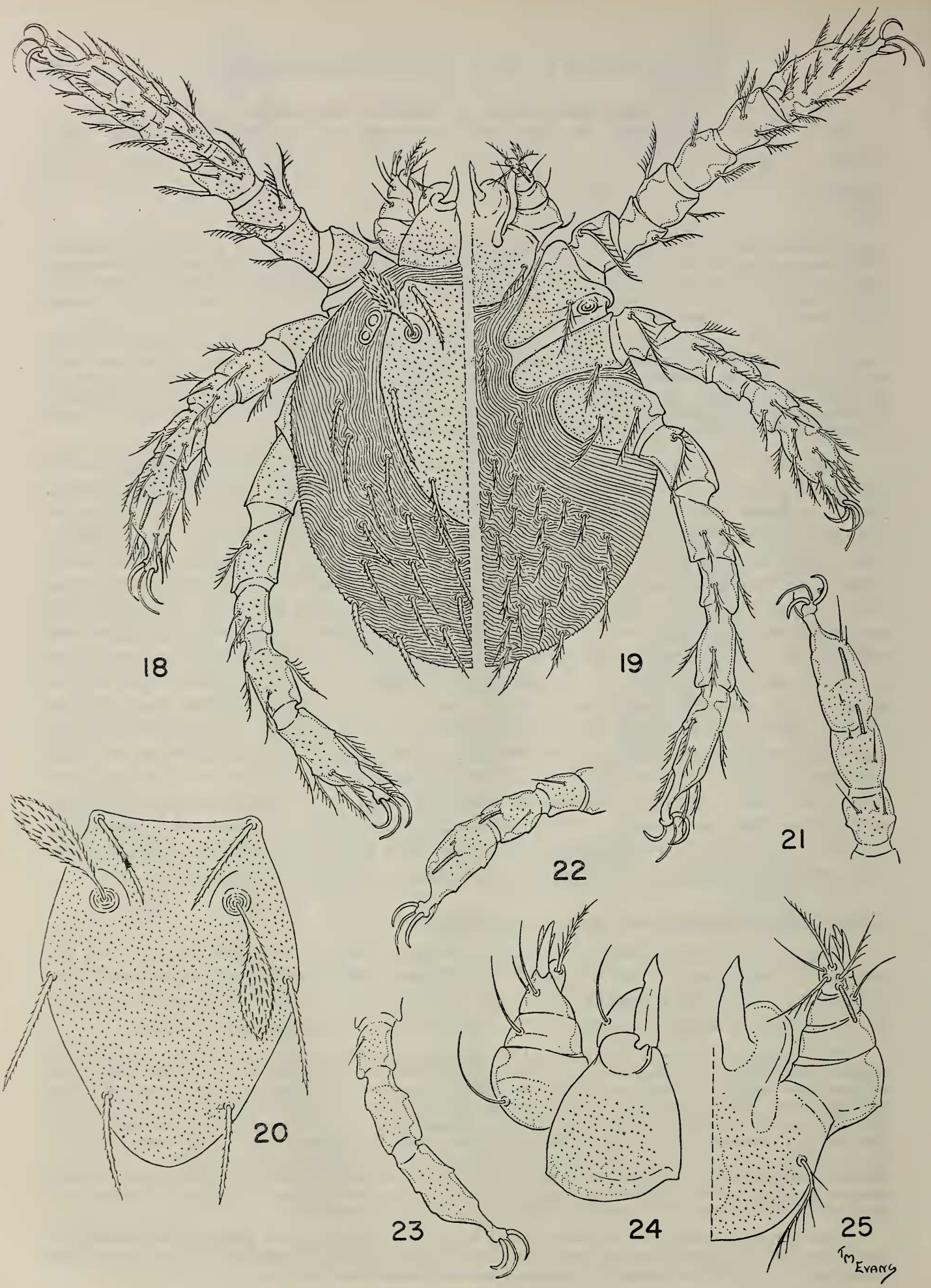
Comment.—*G.* (*Schöngastiella*) *erula* n. sp. seems to be a characteristic but relatively scarce parasite of *Rattus* in or near dense or primary forest in North Burma during the drier months. Most specimens were from *Rattus fulvescens* collected at the height of the dry season at Shingbwiyang in virgin forest or in areas that had been so one year previous. At the time of collection these latter areas were near camps of U.S. Army troops building the Stilwell Road. These sites were still densely covered with trees. In this location, some were from *Rattus rattus sladeni*, a rat occurring in the fringe of scrub terrain along the road. The Myitkyina specimens were also from forested regions. Of the 25 specimens examined, only three were taken in the non-dry months, and these were collected just before or after the monsoon rains (in early June and late October). Despite intensive search, none of these mites were taken in areas of truly secondary growth as near Ledo, Assam or near the Sumprabum Road, 6 miles north of Myitkyina, nor were any collected during the rainy season. Four specimens, from four different individual hosts, are remarkable in possessing only 11-21 dorsal setae instead of the normal 28-30. No other significant differences could be detected between these specimens and typical *erula*. One of these forms was from a host (No. 819) which also carried specimens of *erula* designated as paratypes. This variation in the number of dorsal setae is surprising, but with insufficient knowledge of the taxonomy of these mites, it is felt best to consider these four specimens as aberrant forms rather than as distinct specimens of subspecies.

Gahrliepia (**Schöngastiella**) **helata** n. sp. (figs. 18-25).

Diagnosis of Larva.—Near *G. liota* n. sp. in that coxae III are bisetose and in that the scutum is of small size. Separable mainly by the shape, measurements and proportions of the scutum, i.e.—PPW with a mean of 29μ, not 21: A-PP 67 not 56: scutum evenly curved posterior to PW, instead of being constricted at that point and then becoming slightly sinuate.

Description of Larva.—*Body:* subovate; in engorged specimens about 200 × 128μ. Anterior eye approximately 6.4 × 3.2μ; posterior eye about 7 × 5μ. *Gnathosome:* as in *liota*. *Scutum:* broad and elongate as in *erula* n. sp. but shorter than that species, about 80 × 60μ at maxima, anterior margin almost straight; lateral margins evenly but slightly convex; posterior margin broadly rounded; extending beyond PPL for a distance less than 1/6 length of scutum. Sensillae about 34 × 11μ, inserted at level slightly less than halfway between AL and PL. Scutal setae near margins of dorsal plate but not contiguous with them. PPL closer together than are PL setae, but their breadth (PPW) more than half PW. *Body Setae:* Dorsal setae similar to scutal setae; about 30-32 in number in rows of 2.4.8.8.6. the rest irregular. Ventral setae about 40 in number; thin, sparsely plumed, short, the anteriormost about 10μ in length, the postanals about 21. As in *liota* n. sp. regarding bisetose coxa III and sensory setae.

Type Material.—Holotype (U.S.N.M. 2068; U.S.A.T.C. 834-9) and six paratypes ex *Crocidura*, a small shrew, North Burma, Shingbwiyang, 10. i. 1945 (*U.S.A. Typhus Commission*). Holotype and two paratypes in U.S. National Museum; remainder in collection of senior author.



Gahrliepia (*Schöngastiella*) *helata* n. sp.

Dorsum and Venter of Larva 18, 19
Scutum 20
Legs I, II, III 21, 22, 23
Mouthparts, Dorsal 24
Ventral 25

STANDARD MEASUREMENTS IN MICRONS, *G. helata* n. sp.

Slide	AW	PW	PPW	SB	ASB	PSB	A-P	A-PP	PP	AL	PL	DS	PW / Coxa II	PW / SD
Holotype ...	34	52	29	35	17	64	36	64	17	28	27	26	52/46 =1.13	52/81 =0.64
Paratypes (6) Mean ...	32	54	29	34	17	66	36	67	18	28	29	25	1.16	0.66
Range ...	2	4	2	2	2	3	2	3	2	2	3	4	—	0

Comments.—One specimen from Assam (Ledo vicinity, 22-mile mark on Stilwell Road), ex *Suncus*, agrees fully with the above description. It was collected from the type host and locality of *G. liota* n. sp. above, a species which is close to *G. helata* n. sp. as noted in the diagnosis. However, such a geographic distribution is not unique in this genus. According to our current concepts, the differences in the proportions of the scutum indicate we are dealing with full species, but the possibility of extreme variations within one species must be borne in mind.

Gahrliepia (Schöngastiella) birella n. sp. (figs. 26-34).

Diagnosis of Larva.—Readily separable from all species of *Schöngastiella* known to date by the conspicuous straight row of greatly enlarged dorsal bristles which extend on each side in an oblique sublateral line from level of anterior margin of scutum to lateroposterior margin of body, and by the well-developed anal plate (which is even more specialised in a new species described below). Agrees with *G. erula* n. sp. in coxa III being unisetose and in possessing a scutum which is broadly ovate posteriorly and with PW about 66-70μ. Further separable from *erula* by PSB being below 86, not above 100.

Description of Larva.—Body: ovate, about 325μ × 250μ when engorged. Eye apparently single, but indistinct in specimens extant. *Gnathosome:* of type characteristic of subgenus, but palpal coxae and femora scarcely punctate. *Scutum:* definitely punctate; about three-fourths as broad as long (about 75 × 103μ in holotype); broad throughout, but slightly angled at level of PL; between AL and PL lateral margins somewhat oblique, diverging towards rear; these margins straight between AL and PPL but becoming convex at PPL so that scutum is somewhat constricted above these bristles; caudal margin evenly rounded. Sensillae absent in known specimens. *Body Setae:* Bases of dorsal and ventral setae

STANDARD MEASUREMENTS IN MICRONS, *G. birella* n. sp.

Slide	AW	PW	PPW	SD	ASB	PSB	A-P	A-PP	PP	AL	PL	DS*	PW / Coxa II	PW / SD
25369 ...	38	70	61	38	19	84	27	61	43	21	21	19 / 44-50	70/56 =1.25	70/103 =0.68
25263 ...	38	66	60	36	19	82	29	61	40	19	22	21 / 32-50	66/54 =1.2	66/101 =0.65

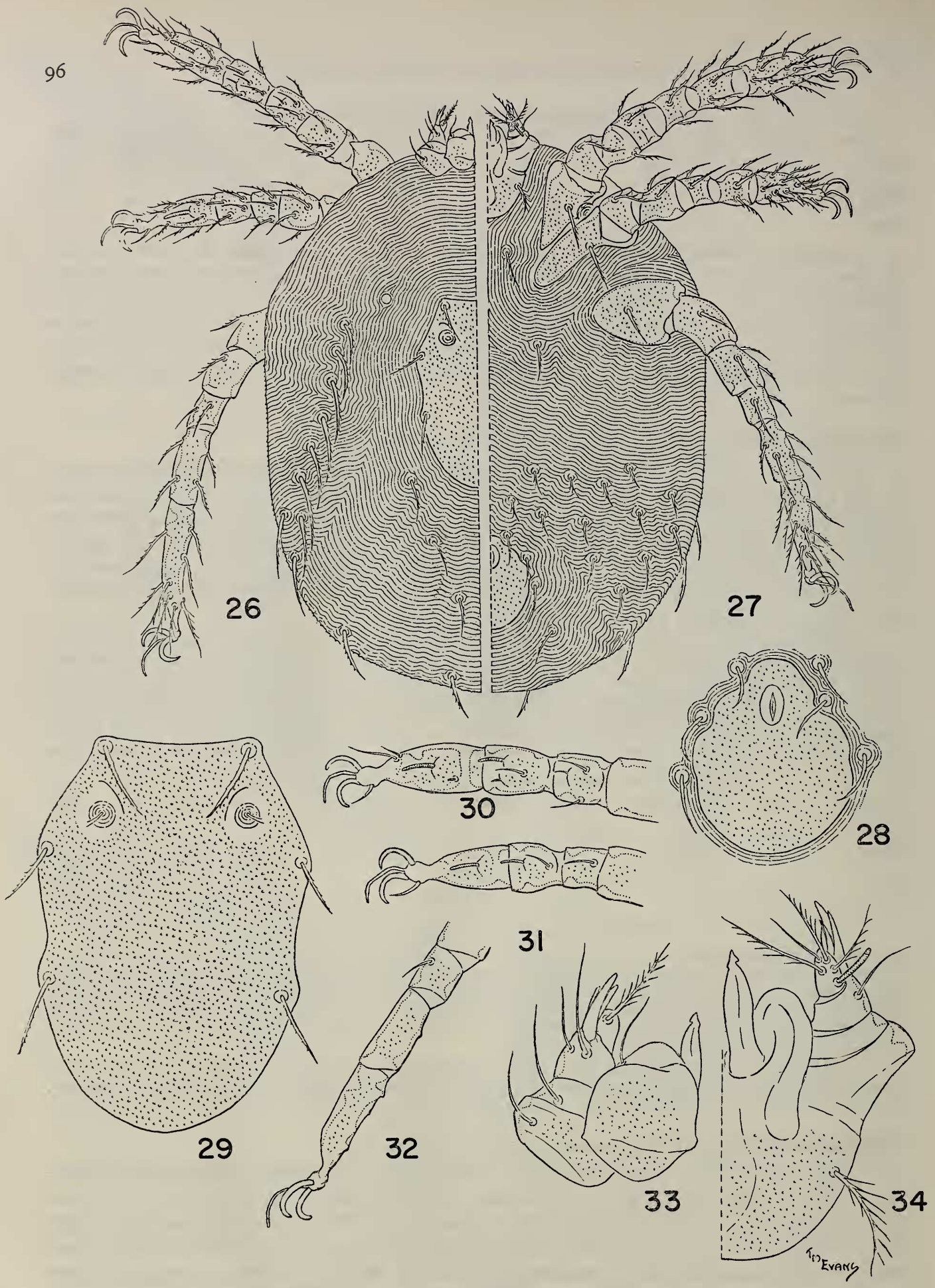
* Dorsal setae in prominent row become progressively larger proceeding caudad.

somewhat enlarged, prominent. Dorsal setae of two types: a thin, sparsely plumed form, only about 20μ in length, about ten in number, all posterior to scutum and subdorsal in position; a second type, much stouter, ranging 32-50μ in length, the longer ones more posterior in position, about eight on each side, forming a well-developed sublateral vertical row. Ventral setae about 36 in number, about 12μ in length. Anal opening surrounded by an ovate bivalvular sclerotization, the structure lying on a distinct slightly crenulate, punctate plate about 30 × 45μ (fig. 28).

Type Material.—Holotype (U.S.N.M. 2070, Colonial Office Research Unit 25369) ex *Rattus bowersi* (Anderson), Malaya, Selangor, Ulu Langat, 4. iii. 1952. (*J. R. Audy*); deposited in U.S. National Museum. A paratype (C.O.R.U. 25263) ex *Rattus*, Malaya, Selangor, Kepong, *ibid;* in collection of senior author.

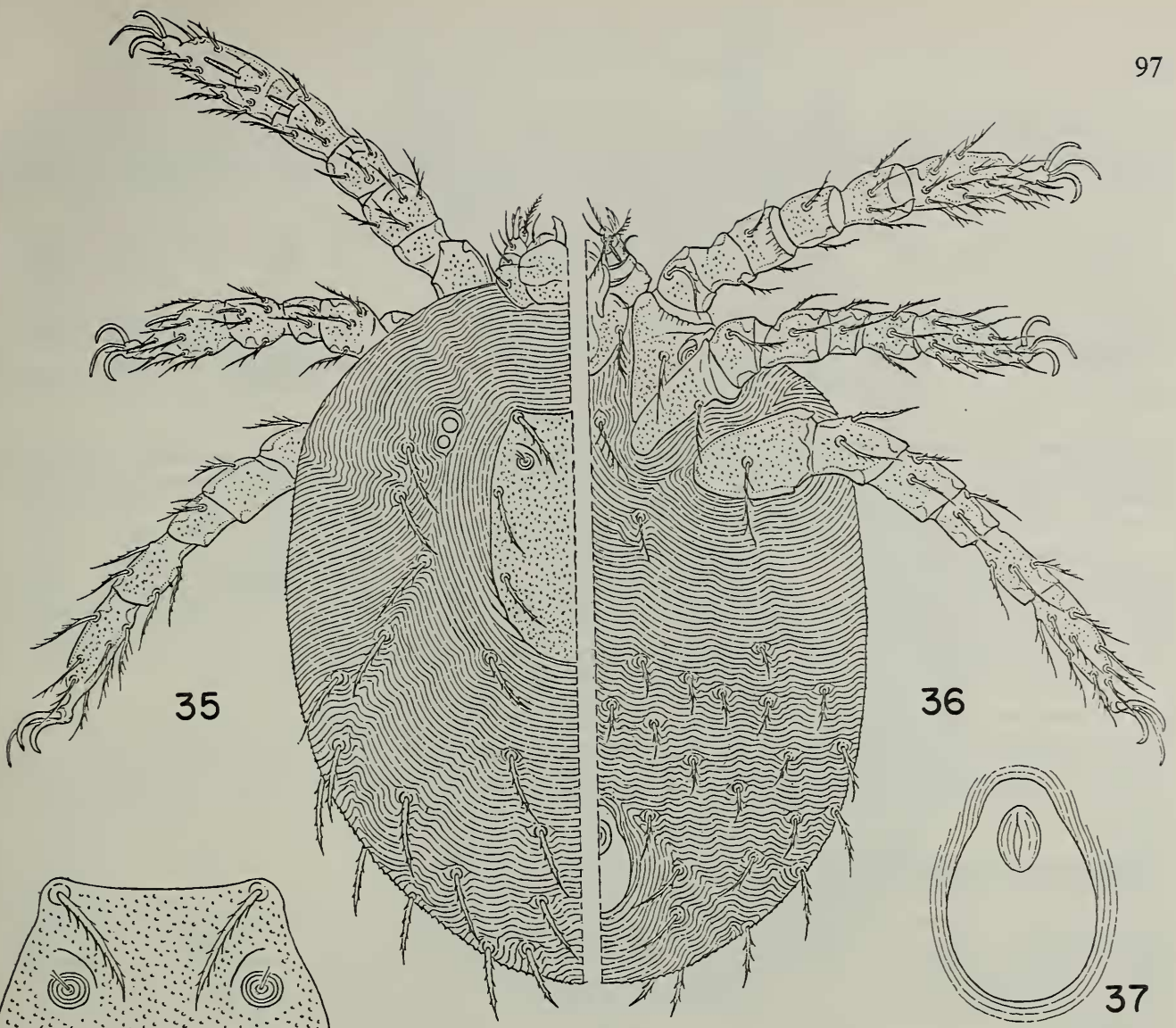
Gahrliepia (Schöngastiella) arona n. sp. (figs. 35-43, p. 97).

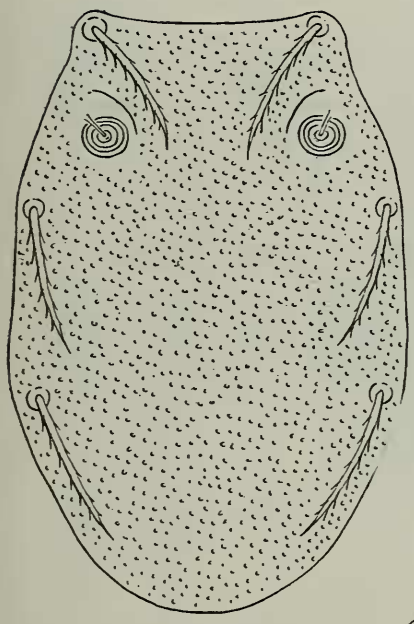
Diagnosis of Larva.—Agrees with *G. (S.) birella* n. sp. in possessing a sclerotized anal plate (the only two species in the genus so characterized). Readily separated from *birella* by the absence of a row of enlarged dorsal bristles on each side of the scutum; by possessing longer AL (29μ versus 19-21) by the greater degree of sclerotization of the anal valvular sclerite and anal plate; the anal plate 3/4 as broad as long instead of virtually as broad as long; anal plate smooth, not punctate; and by the scutum being evenly rounded laterally.

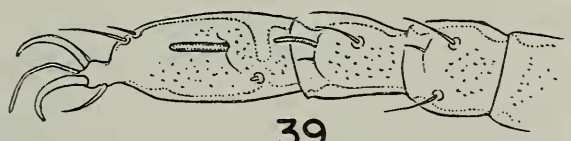


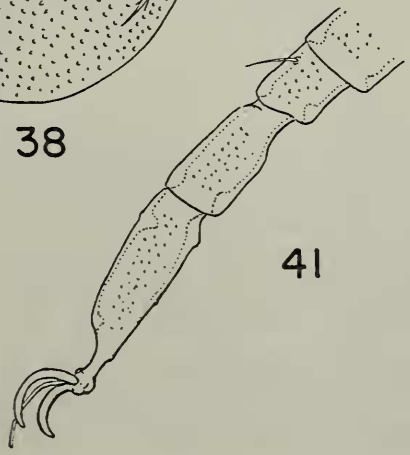
Gahrliepia (*Schöngastiella*) *birella* n. sp.

Dorsum and Venter of Larva 26, 27
Anal plate 28
Scutum 29
Legs I, II, III 30, 31, 32
Mouthparts, Dorsal 33
Ventral 34









Gahrliepia (*Schöngastiella*) *arona* n. sp.

Dorsum and Venter of Larva 35, 36
Anal plate 37
Scutum 38
Legs I, II, III 39, 40, 41
Mouthparts, Dorsal 42
Ventral 43

Description of Larva.—Engorged specimen 364×298μ. *Gnathosome:* as in *G. birella* n. sp., scutum also similar but lateral margins more evenly rounded, not as angulate anteriorly and lacking a median constriction; more finely punctate. Sensillae absent in specimens extant. *Body Setae:* Bases of dorsal

STANDARD MEASUREMENTS IN MICRONS, *G. arona* n. sp.

Slide	AW	PW	PPW	SB	ASB	PSB	A-P	A-PP	PP	AL	PL	DS	PW / Cox II	PW / SD
Holotype ...	37	64	62	37	21	85	34	69	37	29	26	26	62/52 =1.15	62/106 =0.59
Paratypes (15) Mean ...	35	60	57	35	22	82	34	66	35	30	26	27	59/50 =1.18	59/104 =0.57
Range (+ or −) ...	2	4	5	3	2	4	2	4	2	2	2	3	—	—

and ventral setae somewhat enlarged, prominent. Dorsal setae relatively long and thin, about 28 or 30 in number; 3 or 4 of these singly in an irregular line midway between lateral margins of scutum and sides of body. Ventral setae about 36 in number, about 15μ in length. Anal plate (fig. 37) ovate, about 50×36μ nearly as well sclerotized as scutum; the valvular sclerite around anal aperture well demarcated.

Type Material.—Holotype (U.S.N.M. 2069; C.O.R.U. 29214). and two paratypes ex *Rattus mülleri* (Jentinck), Malaya, Selangor, Ulu Langat, 5.viii.1952 (*J. R. Audy*), in U.S. National Museum. Two paratypes, with same data, in British Museum of Natural History, and 5 *ibid*, in collection of Colonial Office Medical Research Unit, Kuala Lumpur. Two paratypes in collection of senior author, *ibid*, but ex *Rattus whiteheadi* (Thomas), Selangor, Kepong. Twelve additional paratypes with same data as holotype, distributed among various acarological collections.

Comment.—The nymph of this species has been bred by Messrs. Nadchatram and Lee Fatt-Hing of the Colonial Office Unit. It is a typical Gahrliepiine and the anal plate appears to have no homologue in the nymphs. The nymph is to be described later (Womersley and Audy, in MS).

Gahrliepia (Schöngastiella) kalrata n. sp. (figs. 44-52).

Diagnosis of Larva.—Near *G. (S.) ceylonica* Womersley, 1952, in the scutum being markedly and narrowly ligulate posterior to PL and in possessing multisetose coxae III. Separable from that species in that the scutum is proportionately much larger, AW ranges from 47-56μ, not 31 and PW about 47-58μ, not 28. Proportionately large size of scutum reflected in ratio of PW/Coxa-II, which is over 0.84; in *ceylonica* it is less than 0.72. With over 80 ventral setae instead of approximately 60. Coxae III typically bearing 5 setae each and only rarely 4.

Description of Larva.—Approximately 680 by 480μ in engorged specimen. Eye apparently single, at level between AL and SB. *Gnathosome:* with femoral setae slightly barbed or plumed (other palpal setae nude as in *liota* n. sp. and related forms). *Scutum:* markedly narrowed beyond PL so that scutum is flask-shaped; apex rapidly becoming subacuminate beyond PPL. Pseudo-posterolateral bristles (PPL) often inserted at different levels, so that bases are in an oblique line, not horizontal. *Body Setae:* Dorsal

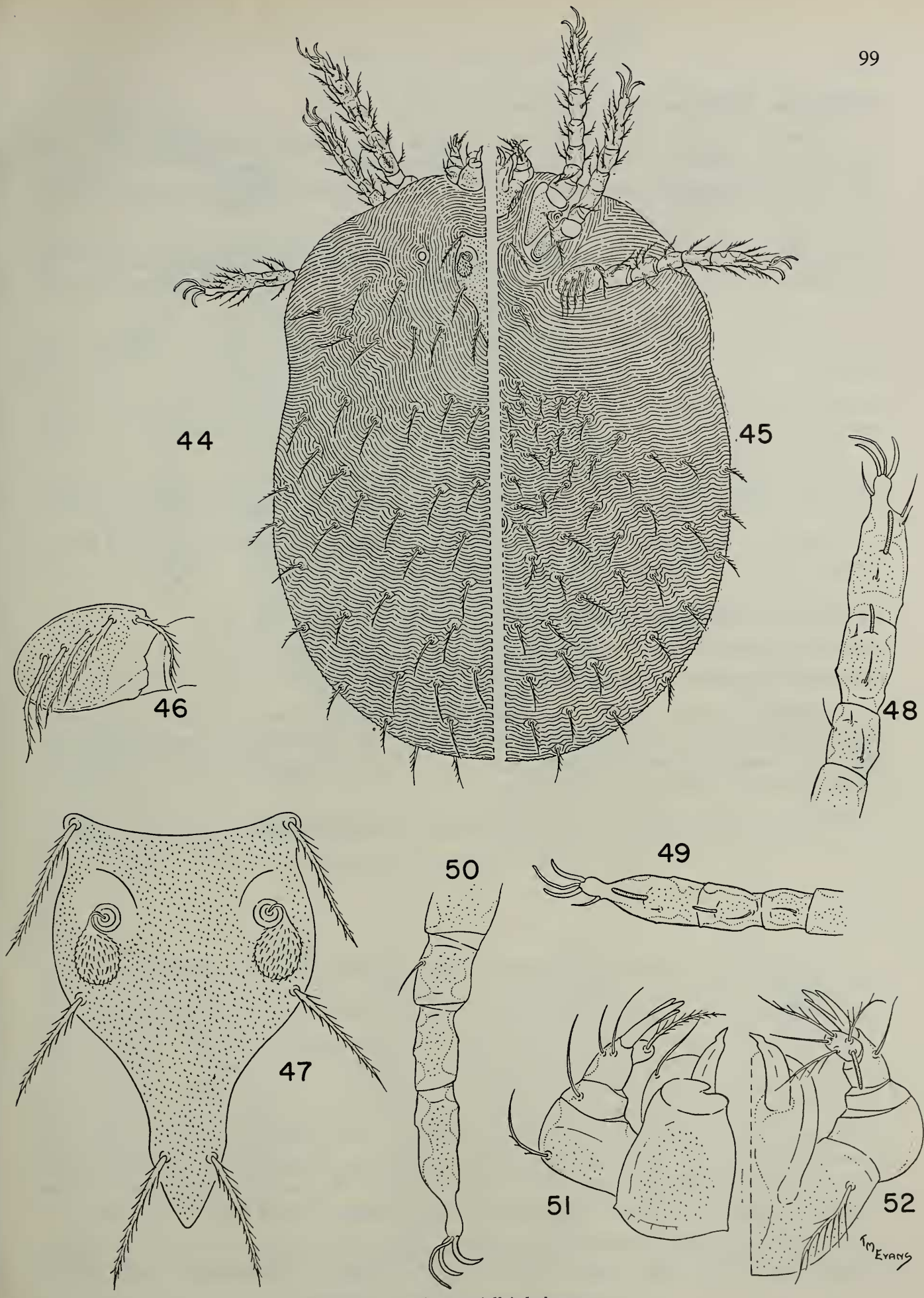
STANDARD MEASUREMENTS IN MICRONS, *G. kalrata* n. sp.

Slide	AW	PW	PPW	SB	ASB	PSB	A-P	A-PP	PP	AL	PL	DS	PW / Cox II	PW / SD
Holotype ...	56	58	19	47	28	98	47	101	25	29	36	31	58/60 =0.96	58/126 =0.45
Paratypes (8) Mean ...	50	53	17	43	26	89	46	94	25	29	36	34	0.98	0.47
Range (+or−) ...	4	6	3	4	3	12	5	11	8	3	2	2	0.08	0.02

setae as scutal setae but slightly smaller; about 70 in number, arranged in rows beginning 4.8.(10) 10 (12) and therefore quite variable. Ventral setae about 85 in number, anteriormost about 21μ in length, posterior ones about 28. Coxae III usually with 5 setae; at times with 5 on 1 and 4 on other, or 4-4; the most dorsal of these inserted at upper lateral angle of coxa, at times inapparent.

Type Material.—Holotype (U.S.N.M. 2071) ex *Rattus rattoides* ssp. (*turkestanicus?*), Kashmir, Sonmarg, viii.1949 (S.*L. Kalra*). Six paratypes, *ibid*, or ex ' Mouse ', Kashmir, Baltal, *ibid*, deposited in collections of the U.S. National Museum, the British Museum, and of the senior author.

Comment.—The specific name was suggested by that of the collector, Lt-Col. S. L. Kalra, who has contributed much to our knowledge of scrub typhus. We are indebted to Dr. Audy for allowing us to study and describe this material, which was sent to him by Kalra.



Gahrliepia (*Schöngastiella*) *kalrata* n. sp.

Dorsum and Venter of Larva 44, 45
Coxa III 46
Scutum 47
Legs I, II, III 48, 49, 50
Mouthparts, Dorsal 51
Ventral 52

Gahrliepia (Schöngastiella) gammonsi n. sp. (figs. 53-60).

Diagnosis.—Near *G. (S.) helata* n. sp. in that the scutum is nonligulate and the third coxae bear 2 setae. Readily separable by virtue of the long narrower scutum (PW:SD=51: 103= 0.50), with PSB 82μ, not approximately 66; with dorsal setal rows commencing 2-6-6-6-, not 2-4-8-8.

Description of Larva.—Body: About 358μ in length, 245 in breadth in engorged specimen. *Gnathosome:* as in liota n. sp. *Scutum:* elongate oval. more narrowed behind PL than anteriorly; setae submarginal. A-PP about twice A-P. PSB nearly four times ASB. *Body Setae:* Dorsal setae essentially

STANDARD MEASUREMENTS IN MICRONS, *G. gammonsi* n. sp.

	AW	PW	PPW	SB	ASB	PSB	A-P	A-PP	PP	AL	PL	DS	PW/Cox II	PW/SD
Holotype ...	33	51	22	35	21	82	39	77	23	25	29	25	51/46 =1.11	51/103 =0.5

as scutal setae but slightly smaller in size; about 28 in number, anterior rows arranged 2.6.6.6. Ventral setae about 52 in number of which approximately 20 arepost-anals; anteriormost about 14μ in length, postanals 17-23μ.

Type Material.—Holotype (only specimen extant) ex *Anourosorex squamipes assamensis* Anderson, a short-tailed shrew; India, Assam, 21 miles north of Ledo, 25.x.1945 (*R. Traub and D. P. Millspaugh* for *U.S.A. Typhus Commission*). Deposited in U.S. National Museum (U.S.N.M. 2072).

Comment.—The species is named for John G. Gammons of the Army Medical Service Graduate School, Washington, who has helped us on many occasions.

Gahrliepia (Schöngastiella) ligula (Radford, 1946) (figs. 61-68, p. 102).

Schöngastiella ligula Radford, 1946, *Proc. zool. Soc. London, 116*, 256, figs. 17,18.

Gahrliepia (Schöngastiella) ligula, Wom., 1952, *Rec. S. Aust. Mus., 10*, 296-297, Pl. 77, fig. B-F.

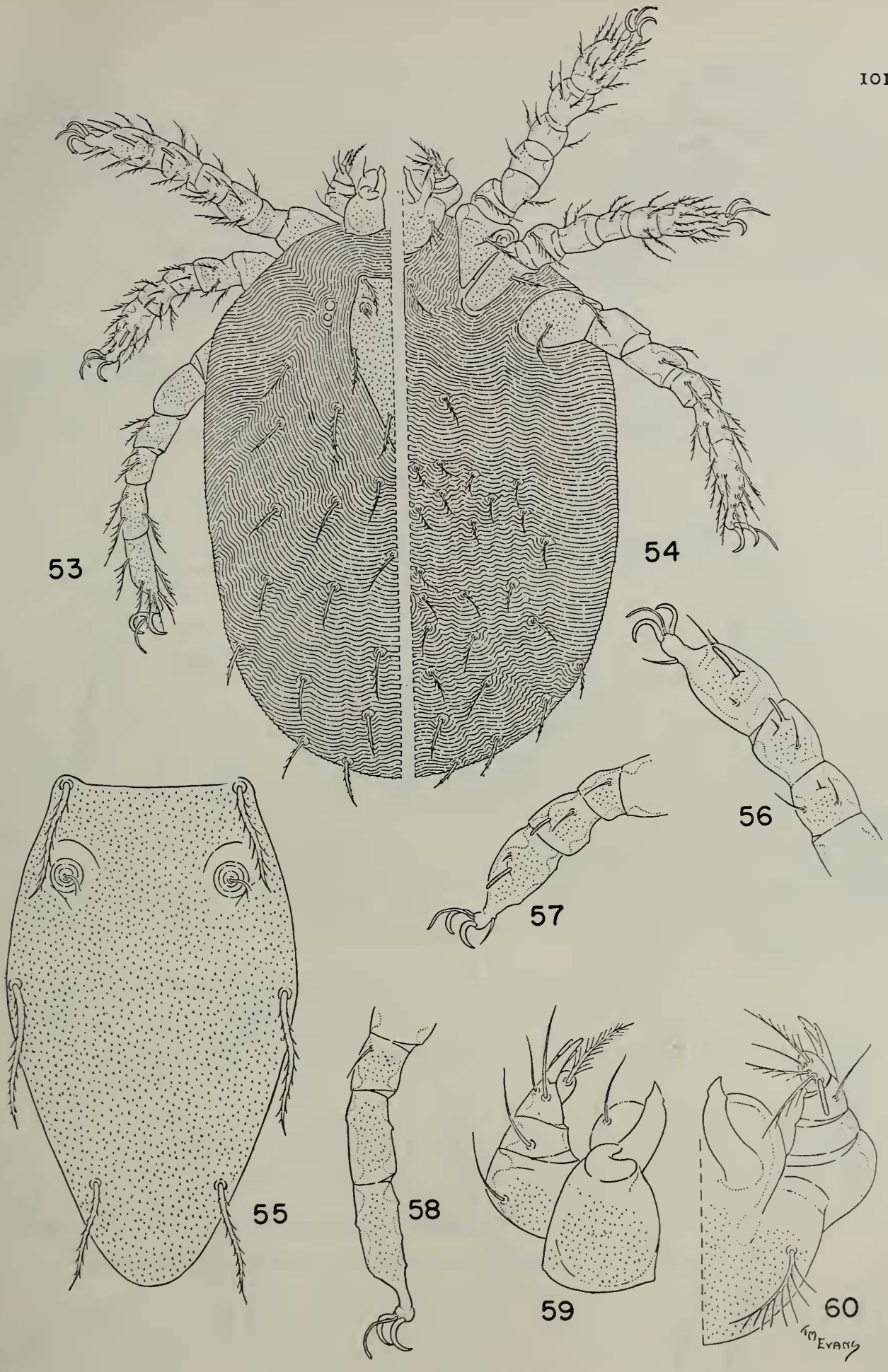
Diagnosis.—Scutum ligulate, the scutum narrowing immediately behind PL to form a tongue-like extension; the pseudo-posterolateral setae close together (9-20μ) and inserted only about 12μ from the apex: all palpal setae about 38-44 in number, in rows of 2-4-8-8, or 2-6-8-2-8; ventral setae about 50 in number.

The Standard Measurements of 25 Assam and Burma specimens of *G. ligula* are as follows:

	AW	PW	PPW	SB	ASB	PSB	A-P	A-PP	PP	AL	PL	DS	PW/Cox II	PW/SD
Mean ...	39	52	14	34	22	58	39	71	9	35	38	35	52/59 =0.8	52/80 =0.65
Range (+or−) ...	8	10	5	4	4	6	4	5	4	8	8	7	0.10	0.10

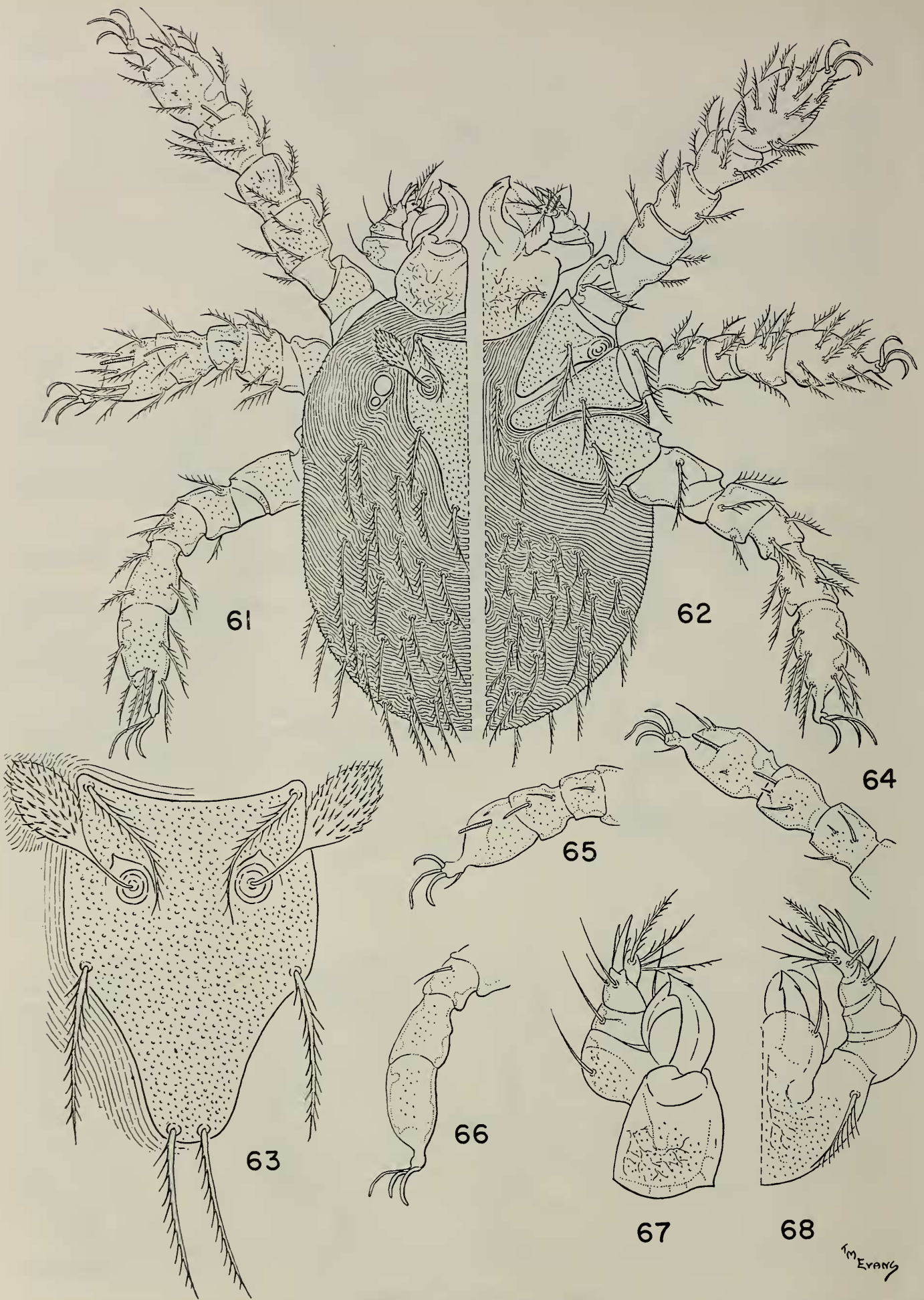
Comments.—Our collections demonstrate that *G. ligula* is even more variable morphologically than the wide range of measurements recorded by Womersley (1952) indicate. The great variations in setal pattern noted above, as well as of the standard data, frequently occur in a series from an individual host. This species is a prime example of how one can be misled by taxonomically studying inadequate series of trombiculids. If one were to study only the extremes of variation, two or three synonyms of *ligula* could very easily be created. Of particular interest in this regard is a group of specimens collected on the floor of a small man-made cave sheltering bats near Myitkyina and not included in the above measured series. These five specimens are peculiar in possessing about 80 ventral setae instead of 50, and the standard measurements are definitely greater, i.e., PW 62, PSB 68. The biological significance of these differences cannot be evaluated at the present time and hence no new name is proposed.

G. ligula was collected during all times of the year on 120 occasions by the U.S.A. Typhus Commission in the Ledo Assam area and in the vicinity of Myitkyina, North Burma.



Gahrliepia (Schöngastiella) gammonsi n. sp.

Dorsum and Venter of Larva 53, 54
Scutum 55
Legs I, II, III 56, 57, 58
Mouthparts, Dorsal 59
Ventral 60



Gahrliepia (*Schöngastiella*) *ligula* (Radford, 1946)

Dorsum and Venter of Larva 61, 62
Scutum 63
Legs I, II, III 64, 65, 66
Mouthparts, Dorsal 67
Ventral 68

Approximately 90 per cent. of the time the hosts were *Rattus flavipectus yunnanensis* or *Rattus rattus sladeni*. The remainder of the hosts were *Mus bactrianus kakhyensis*, *Rattus manipulus*, *Tupaia belangeri versurae*, *Crocidura* (twice), and once each from *Herpestes*, *Suncus*, *Anourosorex*, *Bandicota*, and an unidentified bird. As the types of hosts indicate, the species was rarely taken near or in the primary jungle at Shingbwiyang. In North Burma in the dry season, frequently 40-80 per cent. of the chiggers taken on rats were of this species. In the rainy months in Assam the incidence was only in the vicinity of 10-30 per cent. It is possible that this difference is geographical rather than seasonal.

The distribution of this species around Imphal was noted by Audy (1947) as an "undescribed species of *Schöngastiella*" (Audy, personal communication). It was recorded by the British Scrub Typhus Research Laboratory as common on *R. rattus bullocki* and present on *Rattus* sp. indet., *R. manipulus*, *Callosciurus* sp., *Suncus* (probably *S. murinus*), and *Anourosorex squamipes* in the Manipur area, and as very common on *R. rattus khyensis* and *Bandicota bengalensis* in South Burma—it appeared to be commonest on rodents from villages and towns in both Manipur and South Burma (70-80 per cent of rats or bandicoats infested), and appeared at least in Manipur to be the counterpart of the characteristically urban species *Euschöngastia indica* (Audy *et al*, 1953, and Audy, personal communication). These workers also found that the incidence of *G. ligula* was low during the height of the rainy season (July-August), with a peak in October-November at the end of the rains.

Womersley reports, from collections by Kalra, that this species is also abundant in Kashmir. The frequency of occurrence of this chigger on rats inhabiting scrub terrain suggests that its possible role in scrub typhus should be further studied. This mite is not known to bite man, but it may serve as an intramurine vector of *Rickettsia tsutsugamushi*. *G. ligula* has several times been found in samples selected from batches of chiggers from which *R. tsutsugamushi* was isolated. Kalra (1947) reported a successful isolation in an instance where the sample examined seemed to consist entirely of *ligula*. Although unlikely because of its distinctive colour, the presence of the established vector, *T. deliensis*, could not be absolutely excluded. Davis *et al.* (1947) reported the isolation of several strains of *R. tsutsugamushi* from pools of mites in which a very low percentage of the mites examined consisted of *ligula*. (These were reported as *Schöngastiella* species, but the Gahrliepiine slides and unpublished records of the India-Burma Field Party of the U.S.A. Typhus Commission, in the possession of the senior author make possible this complete determination).

Gahrliepia (Schöngastiella) punctata (Radford, 1946) (figs. 69-76).

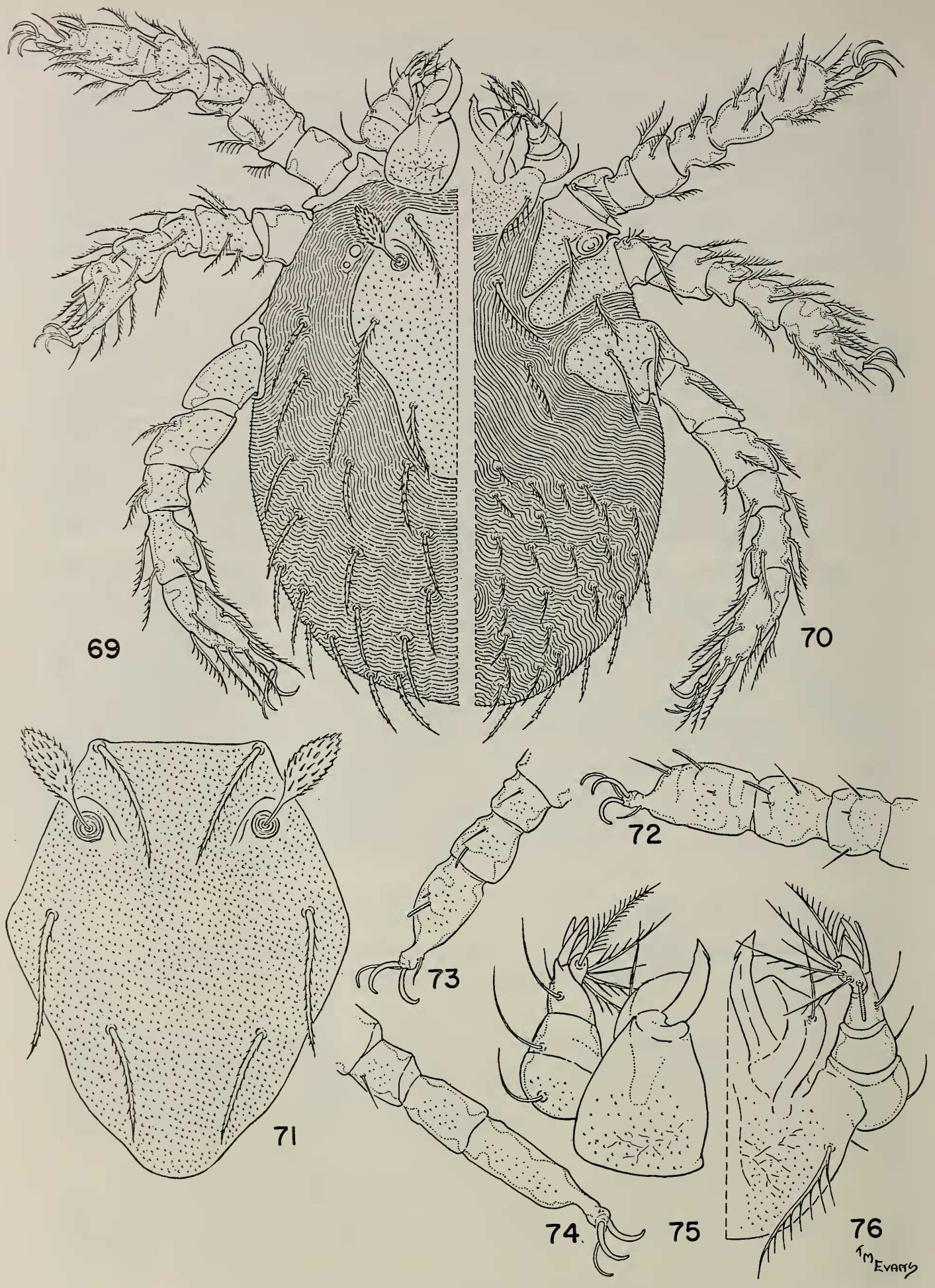
Schöngastiella punctata Radford, 1946, *Proc. zool. Soc. Lond.*, *116*, 256, figs. 19, 20.

Gahrliepia (*Schöngastiella*) *punctata*, Womersley 1952. *Rec. S. Aust. Mus.*, *10*, 299-300, Plate 78, Fig. C.

Diagnosis.—With a large subpentagonal scutum which is characteristically angled at level of PL (fig. 71) but which is rarely rounded and then sinuate as in fig. 69. PW about 73, PPW about 42; Coxae III bisetose. Palpal setal formula N/N/NNN. Sensory setae of legs of usual type (as in *liota* n. sp.). With about 33 dorsal setae in irregular rows beginning 2.4.6.2.6. Ventral setae about 35 in number and 20μ in length.

STANDARD MEASUREMENT OF 15 SPECIMENS OF *G. punctata* FROM ASSAM AND BURMA

	AW	PW	PPW	SB	ASB	BSB	A-P	AA-PP	PP	AL	PL	DS	PW / Cox II	PW / SD
Mean ...	42	71	41	46	21	98	46	83	36	38	41	33	71/63 =1.11	71/119 =0.6
Range (+ or −)	3	6	5	4	3	8	5	6	7	3	3	3	1.1	0.05



Gahrliepia (*Schöngastiella*) *punctata* (Radford, 1946)

Dorsum and Venter of Larva . . . 69, 70
Scutum 71
Legs I, II, III 72, 73, 74
Mouthparts, Dorsal 75
Ventral 76

Comments.—*G. punctata* is a characteristic parasite of shrews in Assam and North Burma. Fifty-four of 60 parasitized hosts examined by the U.S.A. Typhus Commission were shrews of the genera *Crocidura*, *Suncus*, and *Anourosorex*. The remainder were *Rattus rattus sladeni*, *Rattus flavipectus yannanensis* and *Mus bactrianus kakhyensis*. As a rule less than 10 per cent. of the chiggers on the shrews were of this species, but at times as high as 21 of 24 chiggers sampled per host were *G. punctata*. This chigger was not encountered by us in the truly dry season. The localities represented were in scrub vegetation in the Ledo, Assam, area and in the vicinity of Myitkyina, North Burma. Two specimens were collected from a shrew in secondary growth at Shingbwiyang, North Burma. *G. punctata* was originally described from a *Suncus* collected at Kanglatongbi near Imphal, by the British Scrub Typhus Research Laboratory. This unit recorded *punctata* from 49 shrews and 10 *Rattus r. bullocki*, mostly in April-July (51 hosts), but with 5 hosts in August, 2 in September and 1 in November. Two records were from near Kalewa on the Chindwin Burma, but this species was not recorded from South Burma (Rangoon-Prome-Toungoo area) (Audy, personal communication). Womersley records *G. punctata* from Ceylon.

The North Burma and Assam specimens referred by us to this species do not quite agree with Womersley's descriptions. He cites the palpal femoral seta as being lightly branched, while the palpal claw is "apparently bifurcate". In our series the palpal femoral seta is nude and the claw seems trifurcate. Nude setae in this group of trombiculid mites at times appear frayed, while the palpal claw prongs are often difficult to see clearly. The discrepancies are therefore considered inconsequential.

Gahrliepia (Schöngastiella) hipposideros (Audy, 1952).

Schöngastiella hipposideros Audy, 1952, *Bull, Raffles. Mus., 24*, 148-151, figs. 5, 6.

Diagnosis.—The author's diagnosis may be quoted : 'This species is very close to *S. punctata* Radford, from shrews and rodents in Manipur (India), Burma, and Ceylon, and differs in the narrower scutum (posterior setae close to the edge) and the unisetose coxa III, which is 2-setose in punctata (and 4-setose in the closely related *S. kumaonensis* Wom.), and the arrangement of body setae lateral to the scutum (2.4.4. in *hipposideros* and 2.2.4. in *punctata*). In *punctata* the scutum at the level of the PLs is some 7-10μ wider than PW (see fig. 6).' Coxa II measures 41.5μ giving a PW/Coxa-II ratio of 1.35 (personal communication).

Type Material.—A single holotype from a horseshoe bat, *Hipposideros* sp., from Bukit Lagong Forest Reserve, near Kuala Lumpur, 5.ix.1951.

Comment.—This specimen has not been studied by us. Its relationships cannot be properly assessed without more material, and it is included in the present paper to complete records of species of *Schöngastiella* so far described from Malaya.

Comment on the Subgenus *Schöngastiella*

As can be noted from the illustrations and descriptions above, the species of the subgenus *Schöngastiella* are remarkably uniform concerning the setation of the palpi and the sensory setae of the legs. The palpal setae are virtually always nude—only in *G. kalrata* n. sp. and *G. punctata* (Radford, 1946) is there an indication of barbs on these setae. Here the palpal femoral setae is at times frayed or slightly barbed. All the species discussed have the same sensory setae as that described for *G. liota* n. sp.

The postlarval stages are outside the scope of this paper but it may be recorded that nymphs of the following species have been bred and described : *ceylonica*, *ligula*, *punctata* and *arona* (in MS).

Comparative Measurements and Data of Seven Species of Indo-Malaysian Mites of the Subgenus *Schöngastiella*

Species	Scutum posteriorly lingulate	AW	PW	PPW	SB	ASB	PSB	A-P	A-PP	PP	AL	PL	DS	PW	PW	Setae Coxae III	Anal Plate
liota (mean)	+ †	30	46	29	29	16	60	36	56	19	26.5	27.5	23	46/43 =1.07	0.6	2	o
(range)	...	2	3	2	2	1	2	1	2	1	0.5	0.5	1	0.03	0.03		
erula	o	38	70	72	42	20	106	39	89	36	30	35	28	70/54 =1.3	0.6	1	o
		3	5	8	3	3	5	3	2	6	1	2	2	0.04	0.04		
helata	o	32	54	29	34	17	66	36	67	18	28	29	26	54/45 =1.16	0.66	2	o
		2	4	2	2	2	3	2	3	2	2	3	4	0.04	0.04		
birella	o	38	68	60	37	19	83	28	61	41	20	22	19*/32-50	68/55 =1.2	0.66	1	+
		0	2	1	1	0	1	1	0	1	1	1	...	0.05	0.02		
arona	o	36	61	60	36	21	83	34	68	36	30	26	27	61/51 =1.2	0.59	1	+
		1	3	2	1	1	2	3	1	1	3	0	1	0.03	0.03		
kalrata	+	52	54	17	43	26	89	46	94	25	29	36	34	54/55 =0.98	0.47	5(4)	o
		5	7	3	4	3	12	5	11	8	3	2	2	0.06	0.02		
gammonsi	o †	33	51	22	35	21	82	39	77	23	25	29	26	51/46 =1.11	0.50	2	o
ligula (Radford)	+	39	52	14	34	22	58	39	71	9	35	38	35	52/50 =1.04	0.65		o
		8	10	5	4	4	6	4	5	4	8	8	7	0.07	0.07		
punctata (Radford)	o	42	71	41	46	21	98	46	83	36	38	41	33	71/58 =1.2	0.6	2	o
		3	6	5	4	3	8	5	6	7	3	3	3	0.05	0.05		
hipposideros (Audy)	o	46	56	39	35	21	93	41	76	31	25	34	28	56/41.5 =1.35	0.49	1	o

\+ indicates character is present or applicable
o indicates absence of character
† indicates approximately, more or less

Ranges in microns above or below mean
* indicates dorsal setae become progressively longer in conspicuous row

Summary

In connection with studies on Scrub Typhus in Malaya, North Burma, and India, 9 species of chiggers of the subgenus *Schöngastiella* have been collected. Of these, 7 are new and are described and illustrated in detail. The commonest species found in Assam and North Burma is *Gahrliepia* (*Schöngastiella*) *ligula* (Radford). This is a characteristic parasite of *Rattus* in scrub terrain, although at times occuring on a variety of rodents, insectivores and carnivores. It was rarely collected in or near primary jungle. *Gahrliepia* (*Schöngastiella*) *punctata* (Radford) was collected from 60 small mammals in Assam and North Burma. The great majority of hosts of this species were shrews. The only chiggers of this subgenus found in Malaya are *G.* (*S*). *hipposideros* (Audy), *G.* (*S*) *arona* n. sp. and *G.* (*S*) *birella* n. sp. The two latter species are unique in possessing an anal plate. The following new species were found in Assam and Burma : *G.* (*S*) *liota*, *G. erula*, *G. helata* and *G. gammonsi*. Of these *G. erula* is a parasite of *Rattus*, while the other three apparently infest shrews. *G. kalrata* n. sp. was collected from a mouse in Kashmir.

Chiggers of the subgenus *Schöngastiella* are relatively uncommon as compared with such trombiculids as *Trombicula deliensis* Walch, *T. fulleri* Ewing, and *Euschöngastia indica* (Hirst). Despite intensive collecting, involving hundreds of hosts and thousands of chiggers, some of the new species are represented only by one to three specimens. This group of mites is remarkably uniform insofar as concerns the setae of the palpae and the sensory setae of the legs, taxonomic characters of specific value in other genera.

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